Within the field of high-power second harmonic generation (SHG), power scaling is often hindered by adverse crystal effects such as thermal dephasing arising from the second harmonic (SH) light, which imposes limits on the power that can be generated in many crystals. Here we demonstrate a concept for efficient power scaling of single-pass SHG beyond such limits using a cascade of nonlinear crystals, in which the first crystal is chosen for high nonlinear efficiency and the subsequent crystal(s) are chosen for power handling ability. Using this highly efficient singlepass concept, we generate 3.7 W of continuous-wave diffraction-limited 2 (1.25) μm light at 532 nm from 9.5 W of non-diffraction-limited 2 (7.7) μm light from a tapered laser diode, while avoiding significant thermal effects. Besides constituting the highest SH power yet achieved using a laser diode, this demonstrates that the concept successfully combines the high efficiency of the first stage with the good power handling properties of the subsequent stages. The concept is generally applicable and can be expanded with more stages to obtain even higher efficiency, and extends also to other combinations of nonlinear media suitable for other wavelengths.

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